IEM's AI Modeling: Short-term COVID-19 Projections
Date: 3/18/22

Leveraging over 15 years of support to HHS for medical consequence modeling and our proprietary artificial intelligence (AI) models, IEM believes that our Coronavirus model outputs can be used to assist localities and their medical facilities to better prepare for an increase in hospitalizations, to better plan for and locate drive-through testing facilities, and to determine where increased levels of transmission may be occurring.

We have been refining our AI model over the past month and are confident in its ability to provide accurate 7-day projections that can be used for operational and logistical planning.

AI-based Model Background
IEM is currently using an AI model to fit data from various sources and project new cases of COVID-19. We do <u>not</u> assume the average number of secondary infections (R-value) stays the same over time. IEM's AI model finds the best R-value over time to evaluate how it changes over the course of the outbreak. The IEM modeling team is running ~11 million simulations to fit each state's data and using the best fit for the R-value to project new cases over the next 7 days. The AI models are executed on a daily basis to evaluate the changing dynamics of the COVID-19 pandemic. Our projections have typically been within 10%, and are often within 5%, of actual confirmed cases.

The projections shown in this document are based on data pulled in as of 3/18/22 9 a.m.

Please provide any feedback or send any questions that you might have to us. We are continually updating and improving the model, so your feedback is critical.

Also, if you have more current or refined data for your State, Commonwealth or Territory that you would like IEM to factor in, please let us know.

IEM's Modeling Lead
Dr. Prasith "Sid" Baccam is a **Computational Epidemiologist expert** at IEM with more than **20 years of experience in medical consequence modeling and simulation of disease outbreaks** and medical consequences following hypothetical attacks with biological agents or emerging infectious diseases. He develops key simulation models and decision support tools at IEM, specializing in public health, disaster response, and medical countermeasures (MCM) to enhance data-driven decision making and improve modeling assumptions.

Upon receiving his **Ph.D. in Applied Mathematics and Immunobiology** at Iowa State University, Dr. Baccam worked as a Postdoctoral Research Associate at Los Alamos National Laboratory where he focused on researching viral and immunological modeling. After his stint at Los Alamos, Dr. Baccam has served as Task Lead in multiple public health projects have allowed him to develop expertise as a mathematical biologist and a leader on high-performance modeling and simulation teams.

He has worked with state and local public health officials as well as Federal agencies, including **HHS**, the Centers for Disease Control and Prevention (**CDC**), and the Department of Homeland Security (**DHS**). Dr. Baccam has published numerous papers on public health response models and implications on policy and has been invited to participate in workshops and symposiums held by the Institute of Medicine (now the National Academy of Health). His modeling results have been briefed to the **Executive Office of the President** and informed two presidential policy actions.

Colorado State Projections
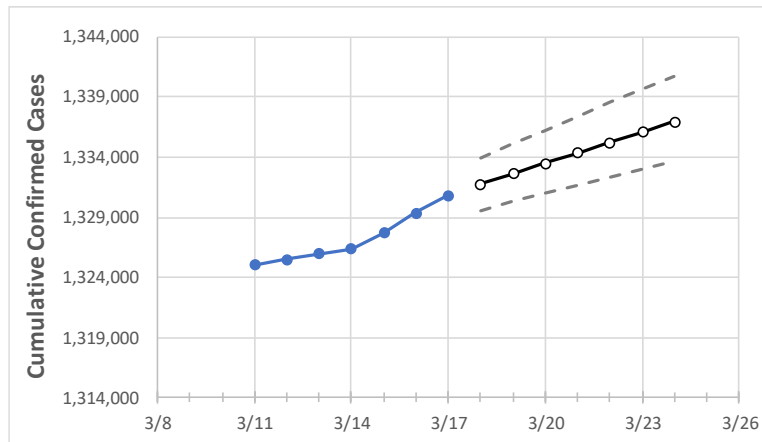
	Actual Confirmed Cases On:				Projected Cases For:						
	3/14	3/15	3/16	3/17	3/18	3/19	3/20	3/21	3/22	3/23	3/24
Colorado	1,326,391	1,327,685	1,329,345	1,330,851	1,331,767	1,332,654	1,333,510	1,334,374	1,335,252	1,336,095	1,336,960

Note: The State's projection shows a "best estimate" curve (the solid line with circles) and the dotted lines are the upper and lower estimates around that best estimate. Our projections have typically been within 10%, and are often within 5%, of actual confirmed cases.

Colorado Counties

	Actual Confirmed Cases On:				Projected Cases For:						
	3/14	3/15	3/16	3/17	3/18	3/19	3/20	3/21	3/22	3/23	3/24
Adams	129,523	129,657	129,781	129,885	129,951	130,016	130,078	130,145	130,210	130,276	130,341
Arapahoe	147,731	147,870	148,000	148,159	148,228	148,302	148,368	148,441	148,503	148,575	148,641
Boulder	61,395	61,469	61,560	61,675	61,728	61,781	61,829	61,884	61,938	61,987	62,039
Denver	165,862	166,005	166,147	166,275	166,367	166,453	166,544	166,633	166,724	166,810	166,897
Douglas	75,869	75,951	76,035	76,104	76,138	76,173	76,205	76,240	76,272	76,304	76,337
Eagle	15,717	15,719	15,732	15,739	15,745	15,751	15,756	15,761	15,767	15,772	15,778
El Paso	180,615	180,772	181,043	181,236	181,362	181,493	181,622	181,741	181,868	181,994	182,115
Gunnison	3,308	3,310	3,312	3,314	3,317	3,319	3,321	3,323	3,326	3,328	3,330
Jefferson	119,219	119,361	119,525	119,671	119,750	119,823	119,898	119,973	120,047	120,120	120,196
Larimer	74,671	74,758	74,943	75,107	75,171	75,233	75,295	75,354	75,417	75,478	75,540
Pueblo	44,774	44,818	44,903	45,002	45,065	45,130	45,194	45,261	45,327	45,395	45,464
Weld	81,149	81,208	81,336	81,452	81,502	81,553	81,599	81,649	81,698	81,745	81,791

Some recipients of our daily COVID-19 short-term (7 day) projections have requested projections of demand for: hospital bed, intensive care unit (ICU) beds, and mechanical ventilation. We realize that different states and localities will have different characteristics for hospital demand of COVID-19 cases, and we are presenting the best assumptions we could find for those medical demands based on scientific literature and health data reporting. Specifically:

- *Beds: For hospitalization, we use a range of 10% and 20% of cases require hospitalization based on CDC's report (MMWR, March 18, 2020) and state reports of COVID-19 cases.*
- *ICU: The CDC report found that 24% of hospitalized cases require ICU care.*
- *Ventilators: Based on clinical data from China and state reports, we assume that 50% of ICU cases require a ventilator.*

If you have other estimates for these assumptions, please share them with us as we work to refine our modeling, assumptions, and data on a daily basis.

*The medical demands shown in the table assume 20% of **cumulative** confirmed cases require hospitalization. To get the medical demand for the assumption that 10% of confirmed cases require hospitalization, simply divide the demand by 2.*

Colorado Medical Demands by County

	Actual Confirmed Cases On:				Projected Cases (Hospitalized) [ICU] {Ventilator} For:		
	3/14	3/15	3/16	3/17	3/19	3/21	3/23
Adams	129,523	129,657	129,781	129,885	130,016 (26,003) [6,241] {3,120}	130,145 (26,029) [6,247] {3,123}	130,276 (26,055) [6,253] {3,127}
Arapahoe	147,731	147,870	148,000	148,159	148,302 (29,660) [7,118] {3,559}	148,441 (29,688) [7,125] {3,563}	148,575 (29,715) [7,132] {3,566}
Boulder	61,395	61,469	61,560	61,675	61,781 (12,356) [2,965] {1,483}	61,884 (12,377) [2,970] {1,485}	61,987 (12,397) [2,975] {1,488}
Denver	165,862	166,005	166,147	166,275	166,453 (33,291) [7,990] {3,995}	166,633 (33,327) [7,998] {3,999}	166,810 (33,362) [8,007] {4,003}
Douglas	75,869	75,951	76,035	76,104	76,173 (15,235) [3,656] {1,828}	76,240 (15,248) [3,660] {1,830}	76,304 (15,261) [3,663] {1,831}
Eagle	15,717	15,719	15,732	15,739	15,751 (3,150) [756] {378}	15,761 (3,152) [757] {378}	15,772 (3,154) [757] {379}
El Paso	180,615	180,772	181,043	181,236	181,493 (36,299) [8,712] {4,356}	181,741 (36,348) [8,724] {4,362}	181,994 (36,399) [8,736] {4,368}
Gunnison	3,308	3,310	3,312	3,314	3,319 (664) [159] {80}	3,323 (665) [160] {80}	3,328 (666) [160] {80}
Jefferson	119,219	119,361	119,525	119,671	119,823 (23,965) [5,751] {2,876}	119,973 (23,995) [5,759] {2,879}	120,120 (24,024) [5,766] {2,883}
Larimer	74,671	74,758	74,943	75,107	75,233 (15,047) [3,611] {1,806}	75,354 (15,071) [3,617] {1,808}	75,478 (15,096) [3,623] {1,811}
Pueblo	44,774	44,818	44,903	45,002	45,130 (9,026) [2,166] {1,083}	45,261 (9,052) [2,173] {1,086}	45,395 (9,079) [2,179] {1,089}
Weld	81,149	81,208	81,336	81,452	81,553 (16,311) [3,915] {1,957}	81,649 (16,330) [3,919] {1,960}	81,745 (16,349) [3,924] {1,962}

For additional information from IEM, please contact Bryan Koon, Vice President of Emergency Management and Homeland Security at bryan.koon@iem.com or 850-519-7966 or Stephanie Tennyson at stephanie.tennyson@iem.com or 202-309-4257.